Identify Regions with a High Frequency of Seismic Activity: A Geospatial Analysis

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Abstract

Seismic phenomena, particularly earthquakes, present substantial geological challenges on a global scale. In this investigation, a geospatial analysis is conducted to systematically identify and map regions exhibiting a high frequency of seismic activity. Through the utilization of Geographic Information System (GIS) tools and the Global Earthquake Archive, the study examines earthquake intensity, magnitude, status, and event types on a worldwide level. The outcomes of the analysis unveil regions of heightened seismic activity, such as Iran, Uzbekistan, and Japan, while also identifying areas of low seismic activity, including Congo and Canada. The research further reveals zones of intense seismic activity in Asia and Northern Europe and delves into the varying magnitudes of earthquakes. The prevalence of the seismic events assessed in this study underscores the significance of ongoing research to enhance global seismic resilience. Consequently, this research contributes to the comprehension of seismic dynamics, thereby enabling informed decision-making and effective disaster preparedness.

***Keywords*:** seismic activity, geospatial analysis, earthquake intensity, magnitude, GIS, earthquake archive, global patterns, seismic hotspots, reviewed status and event types.

1 Introduction

Seismic phenomena, characterized by the occurrence of earthquakes, represent a dynamic geological occurrence that carries far-reaching implications for various regions worldwide. As the Earth's tectonic plates interact beneath the surface, they generate stress that is periodically released, leading to seismic events. It is of utmost importance to identify areas with a significant frequency of seismic activity to effectively prepare for disasters, mitigate risks, and ensure sustainable urban planning. This study employs a geospatial analysis to identify and delineate global regions that experience heightened seismic activity. Understanding seismic activity is not solely an academic endeavor, but also a practical necessity for regions susceptible to earthquakes. Historical evidence shows that seismic events have resulted in catastrophic consequences, emphasizing the crucial need to comprehend the spatial distribution of seismic hotspots. This research aims to provide valuable insights into the field by employing geospatial tools and methodologies to systematically identify and map regions with a consistently high frequency of seismic activity (A.D. Jolly *et al,2007,* Wang, F *et al,2017,* Bai, L. *et al 2016)*

2 Literature Review

The prevailing body of literature concerning seismic activity has predominantly directed its attention toward particular earthquake occurrences, interactions between tectonic plates, and the geological attributes of 2004 earthquake-prone areas (El-Shafei MK,2007, Okada et al., 2004). This study delved into the geological processes that lead to earthquakes, emphasizing the intricate mechanisms that underlie seismic events (M. Ogiso *et al.*2007). The Gorkha Earthquake in 2015 (Samsung Lim *et al,2021)* contributed to the comprehension of seismic patterns by investigating historical events and uncovering trends that have influenced the present understanding of earthquake incidence. Notwithstanding the abundance of information on particular seismic events, there exists a noticeable gap in comprehensive geospatial analyses that systematically identify and map regions with a consistently high frequency of seismic activity. This research intends to build upon the foundation established by these previous studies, to bridge this gap through the utilization of Geographic Information System (GIS) tools for a meticulous geospatial analysis on a global scale (Arnous MO,2004)

3 Methodology

Data serve as the fundamental basis of any examination of geospatial matters, and the Global Earthquake Archive will serve as a primary resource for this investigation. Characteristics such as the intensity of earthquakes, their geographical coordinates (latitude and longitude), depth, and the time of their occurrence will be gathered with great care. Furthermore, geological data, encompassing the boundaries of tectonic plates, will be incorporated to present a comprehensive framework for seismic occurrences', a resilient geospatial information system tool, will be implemented for the analysis of geospatial matters. Techniques related to spatial matters, such as identifying areas with a high frequency of seismic events and the clustering of said events, will be utilized to distinguish regions with such characteristics. The analysis will be carried out across various scales, capturing both larger and smaller patterns of seismic activity. Statistical validation, which includes correlation analyses and testing for sensitivity, will be executed to ensure the dependability of the identified areas with heightened seismic activity. In conclusion, this methodology aligns seamlessly with the research objective of identifying regions with a high frequency of seismic activity through a comprehensive geospatial analysis. Integrating GIS, earthquake archives, and statistical methods ensures a rigorous and insightful exploration of global seismic patterns ((A.R. Ahmad,2013, J.P. Malet *et al 2007,* Neuhäuser, B. *et al,2012)*

4 Results

Earthquake Intensity Heat Map : Global Analysis and Country-wise Distribution

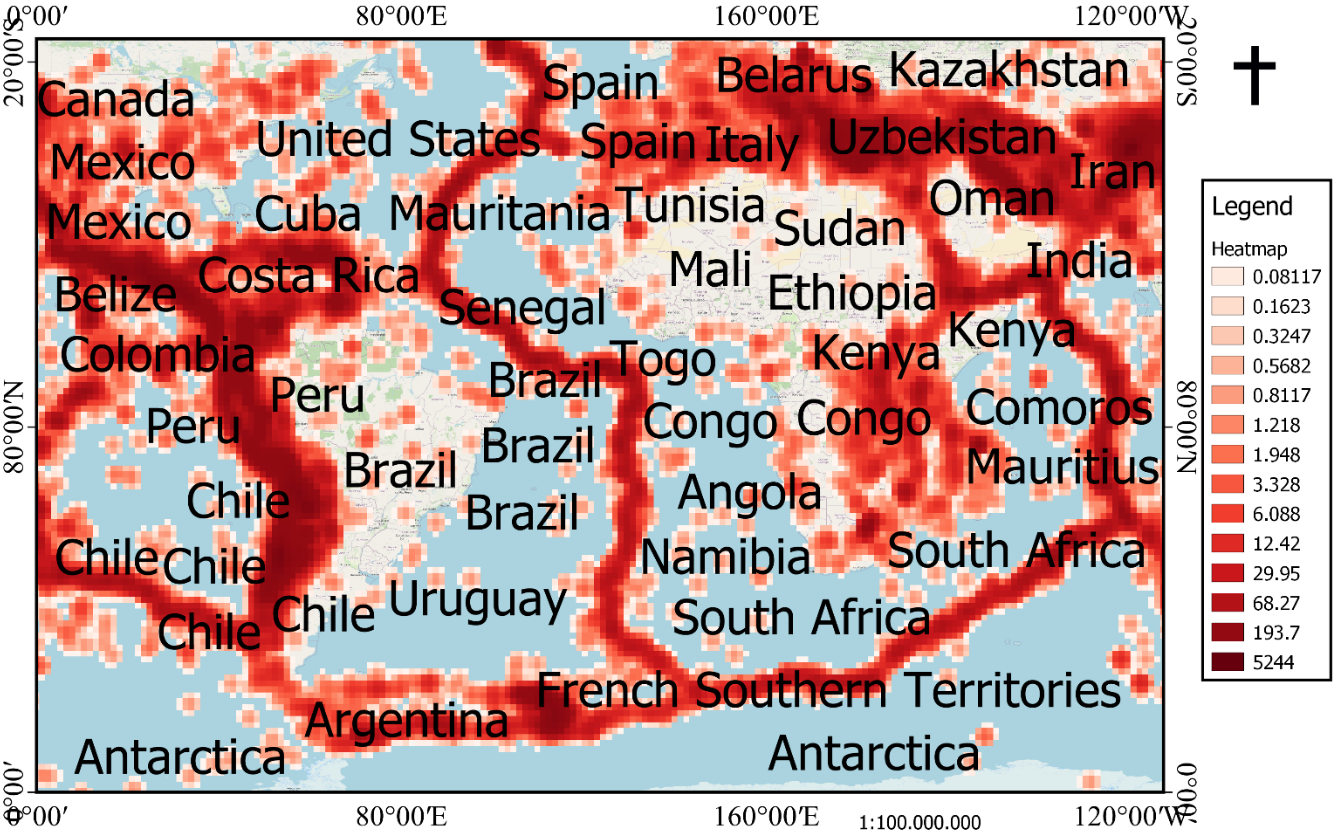


Figure 1 shows the intensity of earthquakes per country

Angola, Mali, Kenya, Canada, the United States of America, Belarus, and others.

Global Seismic Intensity Heat Map: Continental Distribution

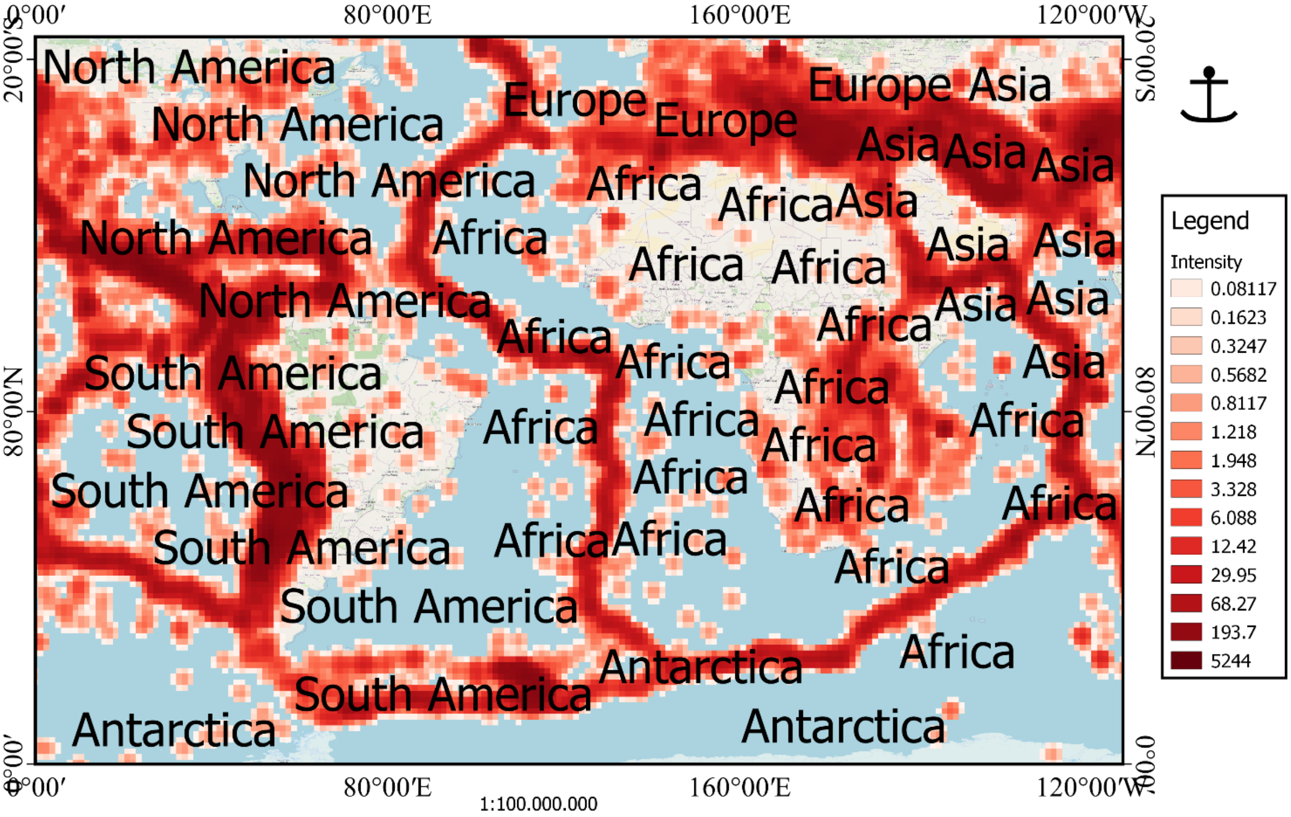
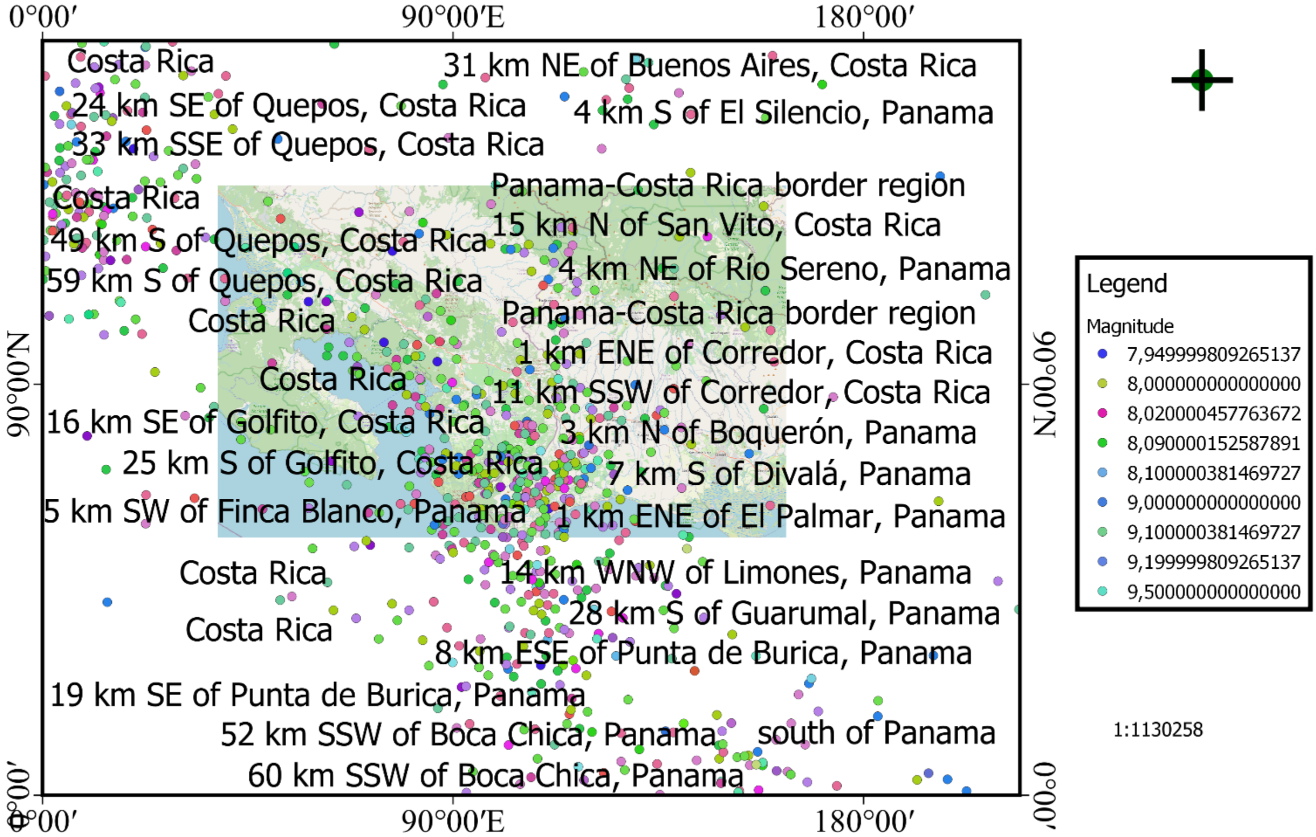


Figure 2 shows the intensity of earthquakes per continent



Worldwide Earthquake Distribution and Magnitude Categorization

0°00′
90°00′E
180°00′
90°00′N
0°00′
Costa Rica
31 km NE of Buenos Aires, Costa Rica
24 km SE of Quepos, Costa Rica
4 km S of El Silencio, Panama
33 km SSE of Quepos, Costa Rica
Panama-Costa Rica border region
Costa Rica
15 km N of San Vito, Costa Rica
49 km S of Quepos, Costa Rica
4 km NE of Río Sereno, Panama
59 km S of Quepos, Costa Rica
Costa Rica
Panama-Costa Rica border region
1 km ENE of Corredor, Costa Rica
Costa Rica
11 km SSW of Corredor, Costa Rica
16 km SE of Golfito, Costa Rica
3 km N of Boquerón, Panama
25 km S of Golfito, Costa Rica
7 km S of Divalá, Panama
5 km SW of Finca Blanco, Panama
1 km ENE of El Palmar, Panama
Costa Rica
14 km WNW of Limones, Panama
28 km S of Guarumal, Panama
Costa Rica
8 km ESE of Punta de Burica, Panama
19 km SE of Punta de Burica, Panama
52 km SSW of Boca Chica, Panama
south of Panama
60 km SSW of Boca Chica, Panama
Legend
Magnitude
● 7,949999809265137
● 8,000000000000000
● 8,020000457763672
● 8,090000152587891
● 8,100000381469727
● 9,000000000000000
● 9,100000381469727
● 9,199999809265137
● 9,500000000000000
1:1130258

Figure 3 shows the magnitude of earthquakes and their locations

Global Earthquake Status: Mapping Seismic Activity Worldwide

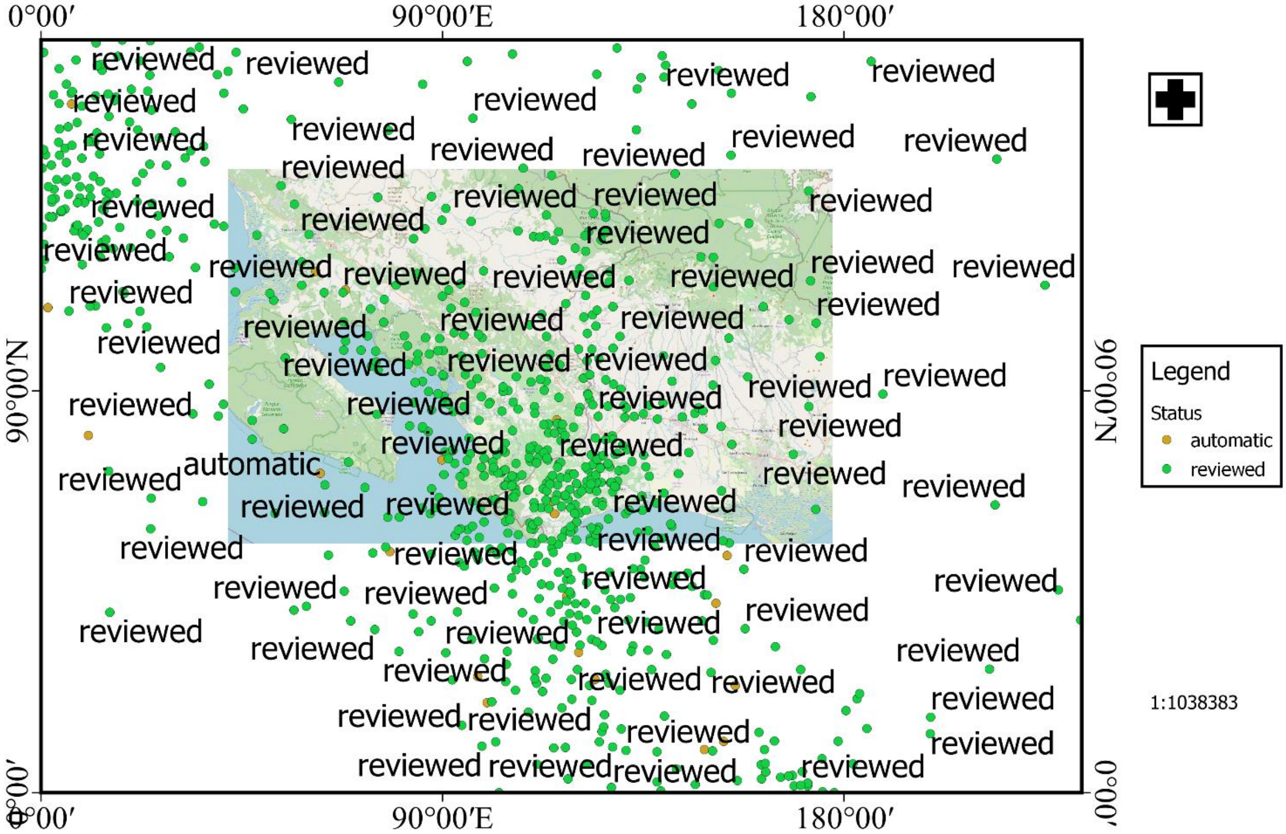


Figure 4 shows the status of seismic activity worldwide

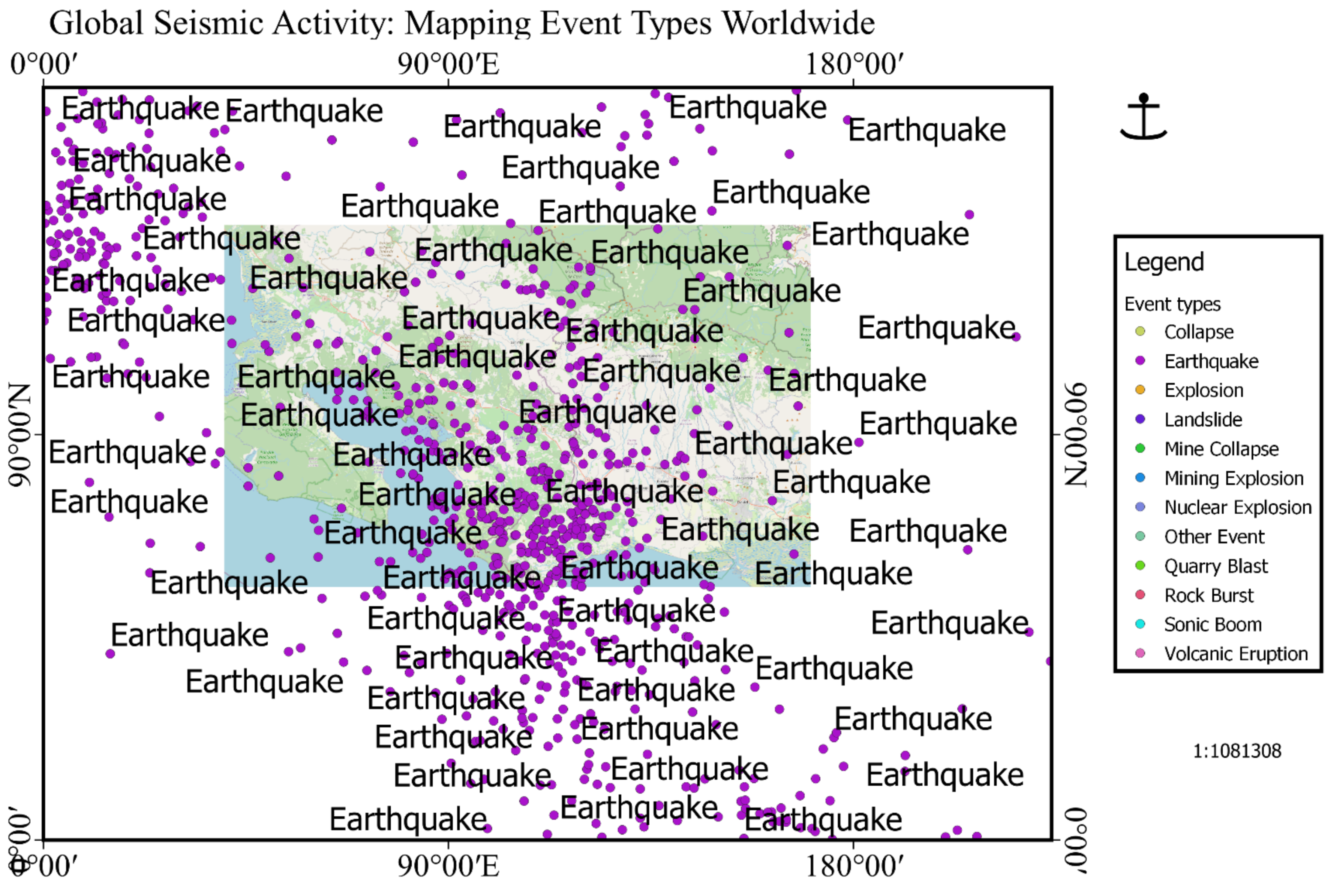


Figure 5 shows the event types of seismic activities globally

5 Discussion

Figure 1 illustrates the countries that serve as focal points for earthquake incidents, encompassing Iran, Uzbekistan, Argentina, Costa Rica, Mexico, Japan, Russia, South Korea, Papua New Guinea, New Zealand, Indonesia, Iraq, and other nations. Conversely, regions with infrequent seismic activities, such as Congo, Angola, Mali, Kenya, Canada, the United States of America, Belarus, and others, function as cold spots. This distribution pattern necessitates further investigation into the geological factors that contribute to the variability in seismic activity across diverse regions (B. Pradhan *et al,2006*). Figure 2 visually demonstrates the magnitude of seismic activities, revealing zones with high-intensity occurrences in Asia, Northern Europe, South America, and specific sections of Africa. The concentration of these high-intensity regions raises inquiries regarding the geological, tectonic, or environmental elements that contribute to the escalated seismic activity in these particular locations. The importance of conducting comprehensive geospatial analyses and geological investigations to comprehend the underlying causes is emphasized. (R. Wright *et al,2002*). Upon closer examination of Figure 3, it becomes evident that the scale of global earthquakes encompasses a broad range, spanning from 7.9 to 9.5. This wide spectrum of magnitudes serves as an indication of the heterogeneous nature of seismic occurrences worldwide. Studying the origins and consequences of earthquakes within this magnitude range is crucial for furthering our understanding of their potential impacts on various facets such as infrastructure, ecosystems, and communities (CEOS, 2003). Figure 4 visually represents the current state of global earthquakes, presenting the automatic and reviewed classifications. It is worth noting that the reviewed classification holds a position of prominence. This prevalence suggests an active involvement on the part of the scientific and seismological communities in the verification and validation of earthquake events. Attaining a comprehension of the review process and its implications for the accuracy and reliability of data is pivotal in interpreting reports on seismic activity (IGOS Geohazards Theme Report, 2004) Figure 5 classifies different categories of seismic events on a global scale, which include collapse, earthquake, explosion, landslide, mine collapse, nuclear explosion, rock burst, quarry blast, volcanic eruption, and other events. This all-inclusive classification provides insight into the various causes and manifestations of seismic activities that occur worldwide. To obtain a more refined comprehension, further investigation into the specific characteristics and consequences of each event type is necessary (D. Pieri *et al.,2004*).

6 Conclusion

In conclusion, the geospatial analysis of seismic activity on a global scale offers valuable insights into the distribution, intensity, magnitude, status, and types of earthquakes across the entire planet. The identification of areas with high activity and those with low activity, the examination of patterns of intensity, and the comprehension of the range of magnitudes all contribute to our understanding of the dynamics of seismic events. The prevalence of reviewed status and the diverse range of event types highlight the necessity for continued research and monitoring. To enhance the resilience of the global community to seismic events, future studies should focus on investigating the underlying geological, tectonic, and environmental factors that influence patterns of seismic activity. This research contributes to the broader scientific discourse on the dynamics of earthquakes and establishes a solid foundation for making well-informed decisions in regions prone to earthquakes. (M. Meghraoui *et al.,2003,* Pokharel, B. & Thapa, P. B,2019*)*

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